Novel Multi Level Clustering Approach to Reduce Energy Consumption during Clustering Process in Wireless Sensor Networks

Deepak Kumar Yadav*, Mayank Kumar Sharma**

*PG Student, Sanghvi Institute of Management & Science, Indore
**Senior Lecturer, Sanghvi Institute of Management & Science, Indore

Abstract- The rapid growth of network utilization raises a new concept as wireless sensor networks (WSN). Sensor networks consist of spatially distributed autonomous sensor to monitor physical or environmental conditions (i.e. temperature, sound pressure etc.) to develop area monitoring, air quality monitoring, and forest fire detection kind of applications. The major design constraint with WSN is resources utilization. Subsequently, work need to perform clustering and routing using node's information for data transmission. The work propose a novel multi cluster policy to reduce energy consumption during clustering process and overcome routing overhead on routing nodes. The proposed policy also avoids frequent election process during clustering by developing seniority table. The approach also investigates network traffic and nodes energy condition before head selection to develop dynamic clustering policy. Furthermore, work also proposed that, any variation in the network can be intimated through fault tolerant message.

Keywords- Wireless Sensor Network, Energy Efficiency, Network Lifetime, Cluster Head, Routing Protocol.

I. INTRODUCTION

In the sensor approach are equipped among a small battery, a tiny microprocessor, a radio transceiver, and situate of transducers that used to congregation information that description the changes in the environment of the sensor node. In order to achieve high energy efficiency and assure long network lifetime, sensor nodes can be organized hierarchically by grouping them into clusters. In clustered sensor networks, the sensor nodes do not transmit their collected data to the base station (BS), but to designated cluster heads which aggregate the data packets and send them directly or via multi-hop communication to the BS. For directly communication, the nodes furthest away from the BS are the most critical nodes, while in multi-hop communication; the nodes closest to the BS are burdened with a heavy relay traffic load and die first. The cluster head role is usually periodically rotated among the nodes to balance the load. Although rotating the cluster head role ensures that sensors consume energy more uniformly, the main problem described above cannot be completely avoided. Thus, choosing the appropriate sizes and number of clusters is essential for the performance of the network lifetime. If the cluster's radius is too large, it will host many nodes and a lot of energy is wasted due to inter-cluster collisions. On the other hand, if the radius is too small, a large number of clusters are required to cover the observation area and many of them will have to transmit their data over a large distance to the sink. As one possible solution to this problem, we will first completely analyze the basic distributed clustering routing protocol LEACH (Low Energy Adaptive Clustering Hierarchy). We will implement local recovery mechanism in order to reconstruct routes when a link failure occurs in the path and it allows the orphan and new deploy nodes to join the network without any interference in the clustering transmissions. We will propose a protocol using the proper node scheduling (ACTIVE and SLEEP) in the individual clustering of the whole network, compare it with the normal LEACH protocol and a model with heterogeneous wireless sensor nodes with its topology to have good energy efficient and increasing lifetime network may be investigate.

II. RELATED WORK

A WSN is required to be energy efficient and have to be intelligent raise network life time. It should guarantee with the aim of every the nodes in the network stay alive as long as achievable. A variety of technique have been described to ensure that battery power could be exploit as efficiently as achievable in all the phases of network operation (i.e. Clustering, Routing, Information Processing and Forwarding)

[1] They propose a transmission controller that utilizes different "grades" of channel side information to schedule packet transmissions in an optimal way, while meeting a deadline constraint for all packets waiting in the transmission queue. The wireless channel is modeled as a finite-state Markov channel (FSMC). They were specifically interested in the case where the transmitter has low-grade channel side information that can be obtained based solely on the ACK/NAK sequence for the previous transmissions. Our scheduler is readily implementable it is based on the dynamic programming solution to the finite-horizon transmission control problem. Also calculate the information theoretic capacity of the finite state Markov channel with feedback containing different grades of channel side information including that, obtained through the ACK/NAK sequence and illustrate that our scheduler achieves a given throughput at a power level that is fairly close to the fundamental limit achievable over the channel.

Ifrah Farrukh Khan at al[2], In this research, the working of few routing protocols has discussed, which are energy aware and some of them also provide reliability in data

transmission. Of various protocols has been presented through simulation results that have been reported by leading researchers for the purpose of their comparison. The challenges faced by wireless sensor networks are also discussed in the research. These challenges (i.e. coverage holes, routing holes, jamming holes, black/sink holes and worm holes) affect the performance of routing protocols.

G.H. Raghunandan at al[3], They presented a comprehensive survey of routing techniques in wireless sensor networks. Overall, the routing techniques are classified based on the network structure into three categories: flat, hierarchical, and location based routing protocols. They also highlight the design tradeoffs between energy and communication overhead savings in some of the routing paradigm, as well as the advantages and disadvantages of each routing technique. Although many of these routing techniques look promising, there are still many challenges that need to be solved in the sensor networks. Highlighted those challenges and pinpointed future research directions in this regard.

In [4] author classified different types of clustering protocols for WSN their advantage and drawbacks. The protocol presented here are concerned on how to increase WSN lifetime and to make efficient use of critical resources located at sensor nodes by creating intelligent clustering schemes.

Clustering technique is one of the effective approaches used to save energy in WSNs [12]. Clustering means organizing sensor nodes into different groups called clusters. In each cluster, sensor nodes are given different roles to play, such as cluster head, ordinary member node, or gate way node. A cluster head (CH) is a group leader in each cluster that collects sensed data from member nodes, aggregate, and transmits the aggregated data to the next CH or to the base station [13,14]. The role of ordinary member node is to sense data from the environment they deployed.
Gate-way nodes are nodes belonging to more than one clusters and their role is to transmit data between two clusters.

Furthermore, many different traditional clustering algorithms for wireless ad-hoc networks have been pro-posed by [15-17]. These clustering algorithms are not suitable for sensor networks because in ad-hoc networks, the primary concern is quality of service (QoS) and energy efficiency is the secondary. But in WSNs, the primary concern is the energy efficiency in order to extend the utility of the network [17].

III. REQUIREMENTS

In current years, there has been an increasing awareness in WSN. One of the most important issues in wireless sensor network is developingan energy-efficient routing protocol. Since the sensor nodes have limited available power, energy conservation is a significant issue in wireless sensor network for nodes and network life. Most of the existing routing protocols for sensor networks don't turn off the radio frequency completely. They speed up the energy consumption. LEACH (Low Energy Adaptive Clustering Hierarchy) is a clustering-based protocol that non-cluster-head nodes will turn off their RF completely until their pre-allocated time slot. However, LEACH has a drawback that the cluster is not evenly distributed due to its randomized rotation of local cluster-head. In this research we propose a MECH (Maximum Energy Cluster Head) routing protocol. It has self-configuration and hierarchical. We will propose architecture can be use inside the clusters between cluster head nodes and also between sink nodes if necessary allowing the effective coverage of large sensing areas. The routing table structure along with the time bounded structure of the protocol, provides efficient upstream and downstream traffic management and allows a wide range of constrained applications for WSN's and implement local recovery mechanism in order to reconstruct routes when a link failure occurs in the path and it allows the orphan and new deploy nodes to join the network without any interference in the clustering transmissions.

IV. SECURITY FLAWS

Individual sensor nodes in a WSN are inherently resource constrained. They have limited processing capability, storage capacity, and communication bandwidth. Each of these limitations is due in part to the two greatest constraints — limited energy and physical size. The design of security services in WSNs must consider the hardware constraints of the sensor nodes:

- Energy: energy consumption in sensor nodes can be categorized into three parts.
- Energy for the sensor transducer.
- Energy for communication among sensor nodes.
- Energy for microprocessor computation

The study in [2, 3] found that each bit transmitted in WSNs consumes about as much power as executing 800–1000 instructions. Thus, communication is more costly than computation in WSNs. Any message expansion caused by security mechanisms comes at a significant cost. Further, higher security levels in WSNs usually correspond to more energy consumption for cryptographic functions. Thus, WSNs can be divided into different security levels, depending on energy cost.

- Computation- The embedded processors in sensor nodes are generally not as powerful as those in nodes of a wired or ad hoc network. As such, complex cryptographic algorithms cannot be used in WSNs.
- Memory- Memory in a sensor node usually includes flash memory and RAM. Flash memory is used for storing downloaded application code and RAM is used for storing application programs, sensor data, and intermediate computations. There is usually not enough space to run complicated algorithms after loading OS and application code. This makes it impractical to use the majority of current security algorithms. With an Intel Mote, the situation is slightly improved, but still far from meeting the requirements of many algorithms.
- Transmission Range- The communication range of sensor nodes is limited both technically and by the need to conserve energy. The actual range achieved from a given transmission signal strength is dependent on

various environmental factors such as weather and terrain

V. PROPOSED METHODOLOGY

This e scope of multi cluster-head policy in wireless sensor networks interactions to cluster-head and avoids redundant exchange of messages among sensor nodes. Moreover, clustering can stabilize the network topology at the level of sensors and thus cuts on topology maintenance overhead. Sensors would care only for connecting with their cluster-head and would not be affected by changes at the level of cluster-head. The cluster-head can also we will implement optimize management strategies to further enhance the network operation and prolong the battery life of the individual sensors and the network lifetime. A cluster-head can schedule activities in the cluster so that nodes can switch to the low-power sleep mode and reduce the rate of energy consumption. Furthermore, sensors can be engaged in a round-robin order and the time for their transmission and reception can be determined so that the sensors reties are avoided, redundancy in coverage can be limited, and medium access collision is prevented this work improve proposes energy efficient multilevel clustering schemes for wireless sensor networks are extremely energy constrained with a limited transmission range. Due to large area of deployment, the network needs to have a multi-level clustering protocol that will enable far-off nodes to communicate with the base station using the proper node scheduling (ACTIVE and SLEEP) in the individual clustering of the whole network, compare it with the normal LEACH protocol and a model with heterogeneous wireless sensor nodes with its topology to have good energy efficient and increasing lifetime network may be investigate.

The routing algorithm used in the wireless sensor network features the clustering method to reduce the amount of data transmission from the energy efficiency perspective. However, the clustering method results in high energy consumption at the cluster head node. Dynamic clustering is a method used to resolve such a problem by distributing energy consumption through the re-selection of the cluster head node. Still, dynamic clustering modifies the cluster structure every time the cluster head node is re-selected, which causes energy consumption. In other words, the dynamic clustering approaches examined in previous study involve the repetitive processes of cluster head node selection. This consumes a high amount of energy during the set-up process of cluster generation. In order to resolve the energy consumption problem associated with the repetitive set-up, In This research we will proposes a novel multi cluster policy that prompts a single set-up process with a high level of energy consumption. The novel multi cluster policy balances energy consumption among the sensor nodes by fixing a constructed cluster and selecting a cluster head node within the cluster based method. Furthermore, an abnormal node is eliminated when the cluster head node is we will modify using a fault-tolerant message.

- This work will completely analyze the basic distributed clustering routing protocol LEACH (Low Energy Adaptive Clustering Hierarchy).
- The objective of this work is to minimize the energy consumption and balance the energy in the network.
- This work will propose an architecture that can be used inside the clusters, between cluster head nodes and also between sink nodes if necessary allowing the effective coverage of large sensing areas. The routing table structure along with the time bounded structure of the protocol, provides efficient upstream and downstream traffic management and allows a wide range of constrained applications for WSN's.
- Our proposed work will implement the local recovery mechanism in order to reconstruct routes when a link failure occurs in the path and it allows the orphan and new deploy nodes to join the network without any interference in the clustering transmissions.
- Our proposed work will perform a new power-aware formulation and also define in order to enhance the cluster head selection and performance comparison with LEACH algorithm.

Developing a clustering protocol in WSN must be such that it is energy efficient and increases the network life time as a whole of doing so we must see that all the nodes lasts for as long as possible. Various approaches have been previously described so as the battery power is used as efficiently as possible in all these phases. Some of the previous protocols suggested were:- LEACH[4]:-It's a cluster-based protocol which includes distributed cluster formation. In this a randomized rotation of the cluster head's role is allowed for reducing energy consumption within a cluster and to distribute the energy load evenly among the sensors in the network. HEED [2] has been developed to overcome the drawbacks of LEACH by giving weight to cluster heads by their residual energy and node degree. In [3] they have classified different types of clustering and their advantage & drawbacks. The protocols presented here are concerned on how to increase the WSN lifetime and to make efficient use of critical resources located at sensor nodes by creating intelligent clustering schemes. Various clustering schemes that are developed for different types of networks i.e. active and proactive networks are:-

a) Proactive Networks: - LEACH, LEACH-C

b) Active Networks:- TEEN, Out of which LEACH and HEED are more promising for further modification that can be used to create a more optimal and efficient protocols for WSN used for major of application. Consider that we have set of set sensors dispersed in an area which is a type of environment which need continuous monitoring and the environment is such that it keeps on changing all the time continuously. So here we are considering a large scale WSN. For example: - forest fire detection, air conditioning sensors, environmental monitoring. We have assumed that sensor network has following properties:-

a) The nodes similar i.e. having same initial battery power and are identical capabilities with all other sensors.

b) Links are symmetrical.

c) Sensors are stationary.

d) Nodes are unattended.

e) Nodes have fixed number of transmission power levels.

Some points we have to keep in mind is that clustering should be uniform throughout the area, should have efficient processing capability and the cluster heads are uniformly distributed to have proper load balancing.

Some challenges we have worked on is :- Low complexity and low power design, robustness and zero maintenance, data fusion,MAC layer design, node duty cycle, connectivity etc. As we have distributed our whole clustering process into 3 step there's time allotted for each and every phase and this phase is periodically rotated as there is a network change and also for load balancing so as to increase the life time of the whole system.

In this work we have proposed an approach, which is self adaptive multi cluster-head policy in wireless sensor networks. The fact of sensor network is that the total energy consumed by a network to cater for data gathering and storing is not in one instance rather it is in phases. The phases in clustering where energy is being used is-

a) Cluster formation.

b) Data aggregation within cluster

c) Routing of aggregated data to base station.

The communication between clusters and between cluster and base station is also energy dependent with definite time frame and access protocols. The three Step involved are as follows.

Step I- For this Step that is initial cluster formation and this Step is repeated periodically for which any change in environment is incorporated in our clusters so that our clusters are formed for getting information for useful and efficiently keeping the lifetime of the network as long as possible. For this we use self adaptive algorithm i.e. after a time T_{TH} the cluster recursively calls its cluster formation algorithm. In the cluster formation algorithm at initial stage all the nodes sends its information to its neighbors its node degree and residual energy by this all nodes knows the status of its neighbors the one which greater residual energy and node degree contends for cluster head slots after which the winner node sends one confirmation signal and all other nodes with closer vicinity (in terms of greater received power) replies to this signal by indicating its participation in this cluster here nodes having more than 1 hop away from the CH also become a part of cluster unless they have no other CH node satisfying their requirement also as environment is varying traffic also varies accordingly so we develop varying duty cycle listen and sleep mode as synchronized by the CH to its member nodes which is decided accordingly by some predictive approach.

Step II- In this step mainly deals with steady state i.e. data aggregation phase here data is aggregated from all the nodes in cluster to cluster heads and the data from nodes more than one hop away transfers data by multi-hop method by internal

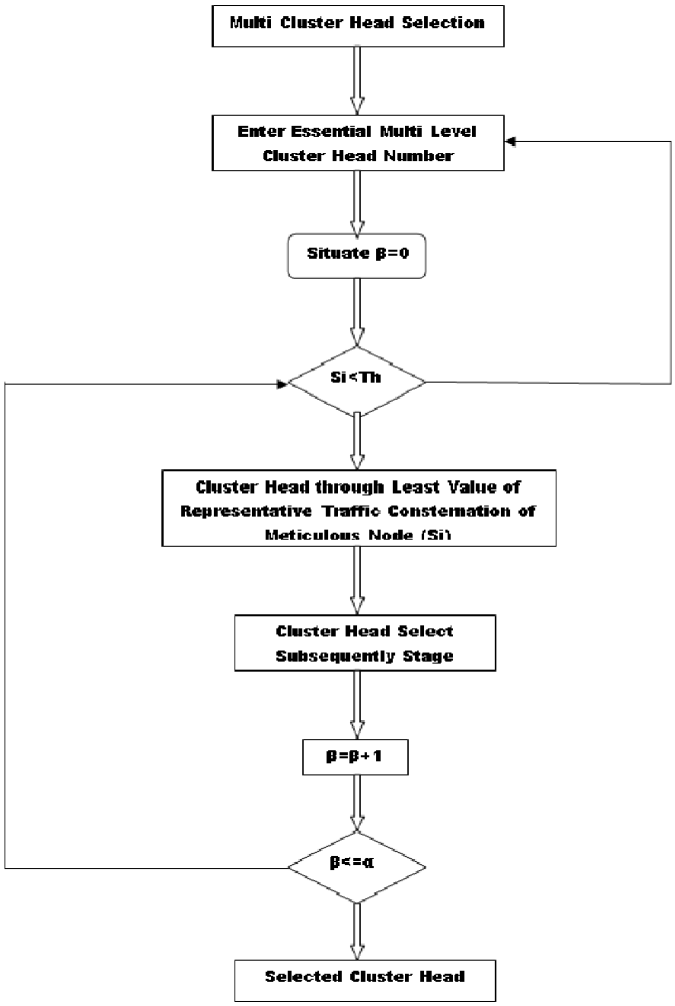

Fig. 1 - Flow Chart of Proposed Protocol

chain based clustering i.e. data from nodes don't directly contact with CH and is transferred to neighboring nodes and it takes turn in transferring to CH as different routes exist within a single cluster. To acquire load balancing and increase network lifetime. In [7] similar method has been proposed but here we using it for within a cluster. In this phase we create a multi cluster-head policy in wireless sensor networks i.e. data from the cluster heads are aggregated to 2nd level of cluster heads and so on. Cluster heads of all lower level of hierarchy aggregate their data to higher level to create a multi cluster-head policy in wireless sensor networks. The criteria for creating multilevel is as follows:- As traffic increases in an changing environment the cluster head can't be used for routing as it may create Over burden on single node. Multi cluster-head policy in wireless sensor networks clustering by traffic as main criteria for creating it. This higher level of hierarchy is created by incorporating a high level traffic area and rather low traffic areas which is in close vicinity and choose the cluster heads which is at low traffic area as the higher level cluster heads. The traffic is measured i.e. number of messages exchanged by neighboring nodes exceeds the threshold value .The cluster head in the traffic area are given a constant number T_{TH} which indicate the level of traffic more the number the cluster head is in mire traffic prone area. Higher layer of clusters are formed by keeping in mind that there is good balance between both types of cluster heads. .

Step III- This approach deals with routing of all aggregated data in the highest level of hierarchy to the base station. In this intra-clustral routing can also use the approach used in so that neighboring nodes can take turn in transmitting to BS rather than following same path and increase the network life time as a whole.

VI. IMPLEMENTATION

The research is based on the Wireless sensor network power simulation on the tools of NS2. The result obtained on the NS2 is further processed on the MATLAB, which is one of prominent engineering tool. In this work the multi layer cluster network is under study. The simulation is based on the different design of the cluster WSN.In the simulation each of the nodes is having variations like the data rate, amount of data, distance of the nodes, the cluster leader and the sink specifications. The first simulation is based on the following cluster WSN. The detailed settings of the each of the node are finalized at the later stage of the project execution.

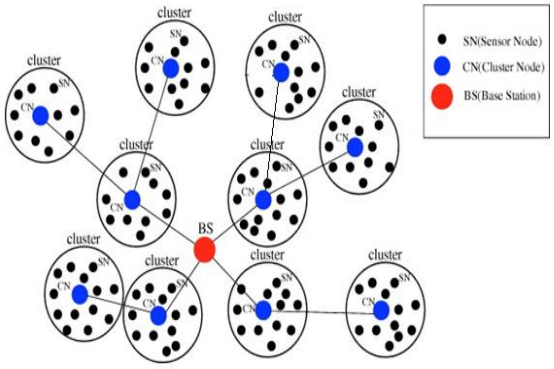

Fig. 2 - The WSN Implementation for the Simulation

The above figure shows a typical WSN network with 10 clusters and having one base station. The links between cluster head and the base station in some cases is not direct, and in some cases direct. There are different sensor nodes in Cluster, which actually sense the data. Each wireless sensor is assumed to have different data length and the transmission frequency; it depends on the type of the sensor and the variation rate of the sensed data. In the simulation we assume the 10 power level and actual power level use in the particular node is depends on the distance and other conditions, which required setting for the simulation.

VII. TESTING STRATEGY

This work will propose a protocol using the proper node scheduling (ACTIVE and SLEEP) in the individual clustering of the whole network, compare it with the normal LEACH protocol and a model with heterogeneous wireless sensor nodes with its topology to have good energy efficient and increasing lifetime network may be investigate. Compare our propose protocol with ACTIVE, SLEEP, LEACH protocol. Prove that our propose protocol effective another protocol like ACTIVE, SLEEP AND LEACH.Our proposed system require network simulator to perform the simulation of wireless nodes in order to prove that our proposed mechanism improve the energy saving WSN Node network Simulator (ns2) will be used to perform simulation. Our system will be tested for 50 WSN nodes in 760*670 m^2 region, created in Ns2. Network Simulator (ns2) is a name for series of discrete event network simulators. Ns2 is used primarily in research and academics. The core of ns-2 is written in C++, but the C++ simulation objects are linked to shadow objects in OTcl and variables can be linked between both language realms. Simulation scripts are written in the OTcl language, an extension of the Tcl scripting language. Ns-2 has a companion animation object known as the Network Animator, nam-1, originally written by Mark Handley, used for visualization of the simulation output and for (limited) graphical configuration of simulation scenarios. It runs on Linux, FreeBSD, Solaris, Mac OS X and Windows 95/98/NT/2000/XP. It is licensed for use under version 2 of the GNU General Public License.

Energy Efficiency- Since nodes are power-sensitive devices whose power sources are often on-board batteries, network quality can suffer if some or all nodes exhaust their energy reserves prematurely. Any overhead energy consumption must be minimized, such as the running of self-test programs. To do this, several energy-saving techniques are introduced which can reduce test energy consumption and test time:

- Test Optimization – Test time is decreased by selecting the most efficient set of instructions to achieve the same test quality.
- Test Combination – There is an inherent overlap in testing separate systems on the same node. The coverage of each test is analyzed and redundancy eliminated.
- Test Concurrency – By reordering and rescheduling tests, test energy and test time can be reduced.
- Test Program Compression – Compressing test programs reduces communication and, in turn, the energy required to perform testing. By taking this approach, we address WSN quality issues that are currently impediments to correctly operating, reliable, available, and energy-efficient networks.

VIII. CONCLUSION

In this paper our proposed policy also avoids frequent election process during clustering by developing seniority table. The approach also investigates network traffic and nodes energy condition before head selection to develop dynamic clustering policy. Furthermore,. All the collected statistics, models and surveys shows that there's a greater need in WSNs for addressing issues on energy consumption to extend their life time of WSN. Routing and data collection are the main activities of a WSN and which consumes most of the energy of a nodes during their lifetime. In literature many routing protocols have been introduced to address the problem of energy consumption to an extent and still there's a need for Energy efficient routing protocols which tries to optimize the overall energy consumption. We will compare our implementation leach algorithm and we proved that our proposed approach more effective.

REFERENCES

[1] Rahul Srivastava and Can EmreKoksal, "*Energy Optimal Transmission Scheduling in Wireless Sensor Networks*", IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, VOL. 9, NO. 5, MAY 2010.

[2] IfrahFarrukh Khan and Dr. Muhammad YounasJaved, "*A Survey on Routing Protocols and Challenge of Holes in Wireless Sensor Networks*", International Conference on Advanced Computer Theory and Engineering, 2008.

[3] G.H. Raghunandan, "*A Comparative Analysis of Routing Techniques for Wireless Sensor Networks*". Proceedings of the National Conference on Innovations in Emerging Technology,2011.

[4] SaminaEhsan and BechirHamdaoui, "*A Survey on Energy-Efficient Routing Techniques with QoS Assurances for Wireless Multimedia Sensor Networks*", IEEE COMMUNICATIONS SURVEYS & TUTORIALS, 2011.

[5] N.P.KARTHICKRAJA, "*A Study of Routing Protocols and A Hybrid Routing Protocol Based on Rapid Spanning Tree and Cluster Head Routing in Wireless Sensor Networks*".

[6] JAMAL N. AL-KARAKI, "*Routing techniques in wireless sensor networks: a survey*", IEEE Wireless Communications, December 2004.

[7] J. Kulik, W. R. Heinzelman, and H. Balakrishnan: "*Negotiation- Based Protocols for Disseminating Information in Wireless Sensor Networks*", Wireless Networks, vol. 8, pp. 169–85 (2002).

[8] M. Chu, H. Haussecker, and F. Zhao: "*Scalable Information-Driven Sensor Querying and Routing for ad hoc Heterogeneous Sensor Networks*", The International Journal of High performance Computing Applications, Vol. 16, No. 3,August 2002.

[9] Sanghita Bhattacharya, SubhansuBandyapadhyay "*A Dynamic Energy Efficient Multi Hop Routing Technique Using Energy Aware Clustering In Wireless Sensor Network*" 978-1-4244-8679-3-IEEE-2011

[10] T.He et al.: "*SPEED*: *A stateless protocol for real-time communication in sensor networks*", in the Proceedings of International Conference on Distributed Computing Systems, Providence, May 2003.

[11] K. Sohrabi, J. Gao, V. Ailawadhi, G.J. Pottie, "*Protocols for self organization of a wireless sensor Network*", IEEE Personal Communications,October 2000,pp.16–27.

[12] X. Guan, W. H. Yang and D. G. Bi, "*EEHCA: An En-ergy-Efficient Hierarchical Clustering Algorithm for Wireless Sensor Networks*," Information Technology Journal, Vol. 7, No. 2, 2008, pp. 245-252.

[13] J. Yang and D. Zhang, "*An Energy-Balancing Unequal Clustering Protocol for Wireless Sensor Networks*," *In-formation Technology Journal*, Vol. 8, No. 1, 2009, pp. 57-63.

[14] D. Wei, S. Kaplan and H. A. Chan, "*Energy Efficient Clustering Algorithms for Wireless Sensor Networks,*" Proceeding of the IEEE International Conference on Communications Workshops, 19-23 May 2008, Beijing, pp. 236-240.

[15] Z. Li, R. Li, Y. Wei and T. Pei, "*Survey of Localization Techniques in Wireless Sensor Networks*," *Information Technology Journal*, Vol. 9, No. 8, 2010, pp. 1754-1757.

[16] Y. Xu, J. Heidemamij and D. Estrin, "*Geogra-phy-Informed Energy Conservation for Ad Hoc Routing*," Proceedings of the ACM/IEEE 7th Annual International Conference on Mobile Computing and Networking, Rome, 16-21 July 2001, pp. 70-84.

[17] J. Chen, J. Fan, X. Cao and Y. Sun, "*GRFR: Greedy Rumor Forwarding Routing for Wireless Sensor/Actor Networks*," Information Technology Journal, Vol. 7, No. 4, 2008, pp. 661-666.

AUTHORS

First Author – Deepak Kumar Yadav, M.Tech.* (PG Student), Sanghvi Institute of Management & Science, Indore, deep.yadav0123@live.com

Second Author – Mayank Kumar Sharma, M.Tech. (Senior Lecturer), Sanghvi Institute of Management & Science, Indore, mayank.sharma@sims-indore.com